USB 3.0 ENGINEERING CHANGE REQUEST FORM

ECN# 001

Name: Huimin Chen Email: huimin.chen@intel.com

Company: Intel Corporation Mailstop: CO5-166

Address: 15400 NW greenbrier pkwy

City: Beaverton State/Province: OR

Country: USA Zip/Postal Code: 97006

Phone: 503-456-0357 FAX: 503-456-0920

Name: Suzanne Vining Email: s-vining@ti.com

Company: Texas Instruments Mailstop: MS8666

Address: 12500 TI Blvd

City: Dallas State/Province: TX

Country: USA Zip/Postal Code: 75243

Phone: 214 480-2119

Name: Hajime Nozaki Email: hajime.nozaki@am.necel.com

Company: NEC Electronics America Mailstop: SC#2302

Address: .2880 Scott Blvd.

City: Santa Clara State/Province: CA

Country: USA Zip/Postal Code: 95050

Phone: (408) 588-5216

USB 3.0 ENGINEERING CHANGE REQUEST FORM

Title: New Addition of Link command LDN
Applied to: USB3.0 (11132008)-final

Brief description of the functional changes proposed:

There is a transition condition described in section 10.3.1.1 "DSPORT.Powered-off". It is copied in the following.

- **From any state if the hub's upstream port link has attempted eight consecutive Rx.Detect events without detecting far-end receiver terminations.**

A likely scenario of this condition is when a USB 3.0 hub is connected to a USB 2 only root port.

A likely LTSSM state of the hub's downstream port when it is directed to "DSPORT.Powered-off" is U0.

When a hub's downstream port is in "DSPORT.Powered-off", its corresponding LTSSM state is "SS.Disabled", where the SS receiver termination is removed.

In the current spec, there is no proper way for a device to detect the above condition, if it has already completed link initialization described in section 7.2.4.1.1 and port configuration described in sections 8.4.5 and 8.4.6. This will result in (1). Device remaining in U0 wasting power; (2). Depending on the channel condition, device overdriving the downstream port's SS receiver.

To address this issue, a new link command, LDN, similar to LUP, needs to be added. LDN was defined during initial spec development and removed due to its redundancy to V_{BUS}'s logical meaning.

Other solutions are also explored, such as using Warm Reset to bring a device to Rx.Detect, and introducing SS.Disabled.Reset. The general consensus is to adopt LDN because of its similarity to LUP.

Benefits as a result of the proposed changes:

To provide a reliable way for a device to detect the removal of a downstream port's SS receiver termination when the link is LI.

USB 3.0 ENGINEERING CHANGE REQUEST FORM

An assessment of the impact to the existing revision and systems that currently conform to the USB specification:

The link layer implementation will be impacted.

1. introduce LDN with similar function to LUP.
2. a downstream port shall send LDN every 10 µs when in LI.
3. an upstream port shall enable LDN detection when in LI.
4. an upstream port shall transition to Recovery if no link command of any type is detected within 1 ms of LI.

An analysis of the hardware implications:

Downstream port: enable an 10 µs timer during LI to send LDN.

Upstream port:

1. enable an 1 ms timer during LI to detect LDN.
2. LTSSM-U0: an upstream port shall transition to Recovery if link command of any type is not received within 1 ms of LI.

An analysis of the software implications:

No.

An analysis of the compliance testing implications:

Same as compliance test for LUP. LDN is observable every 10 µs when the link is in LI.

USB 3.0 ENGINEERING CHANGE REQUEST FORM

Actual Change Requested

(a). From Text (and location): Table 7-4

Link Command Bit Definitions

<table>
<tr><th colspan="2">Class</th><th>Type</th><th rowspan="2">b6~4</th><th>Sub-Type</th></tr>
<tr><th>b10~9</th><th>Link Command</th><th>b8~7</th><th>b3~0</th></tr>
<tr><td rowspan="3">00</td><td rowspan="9">LGOOD_n
LRTY
LBAD
LCRD_x</td><td>00: LGOOD_n</td><td rowspan="9">Reserved
(000)</td><td>b3: Reserved
b2~0: HP Sequence Number
000: LGOOD_0
001: LGOOD_1
010: LGOOD_2
011: LGOOD_3
100: LGOOD_4
101: LGOOD_5
110: LGOOD_6
111: LGOOD_7</td></tr>
<tr><td>01: LCRD_x</td><td>b3~2: Reserved
b1~0: Rx Header Buffer Credit
00: LCRD_A
01: LCRD_B
10: LCRD_C
11: LCRD_D</td></tr>
<tr><td>10: LRTY
11: LBAD</td><td>Reserved (0000)</td></tr>
<tr><td rowspan="3">01</td><td rowspan="3">LGO_Ux
LAU
LXU
LPMA</td><td>00: LGO_Ux</td><td>0001: LGO_U1
0010: LGO_U2
0011: LGO_U3
Others: Reserved</td></tr>
<tr><td>01: LAU
10: LXU
11: LPMA</td><td>Reserved (0000)</td></tr>
<tr><td>10</td><td>LUP</td><td>00: LUP
Others: Reserved</td><td>Reserved (0000)</td></tr>
<tr><td>11: Reserved</td><td>Reserved</td><td>Reserved (0000)</td><td>Reserved (0000)</td></tr>
</table>

USB 3.0 ENGINEERING CHANGE REQUEST FORM

To Text (and location):

Link Command Bit Definitions

<table>
<tr><th colspan="2">Class</th><th>Type</th><th rowspan="2">b6~4</th><th>Sub-Type</th></tr>
<tr><th>b10~9</th><th>Link Command</th><th>b8~7</th><th>b3~0</th></tr>
<tr><td rowspan="3">00</td><td rowspan="3">LGOOD_n
LRTY
LBAD
LCRD_x</td><td>00: LGOOD_n</td><td rowspan="14">Reserved
(000)</td><td>b3: Reserved
b2~0: HP Sequence Number
000: LGOOD_0
001: LGOOD_1
010: LGOOD_2
011: LGOOD_3
100: LGOOD_4
101: LGOOD_5
110: LGOOD_6
111: LGOOD_7</td></tr>
<tr><td>01: LCRD_x</td><td>b3~2: Reserved
b1~0: Rx Header Buffer Credit
00: LCRD_A
01: LCRD_B
10: LCRD_C
11: LCRD_D</td></tr>
<tr><td>10: LRTY
11: LBAD</td><td>Reserved (0000)</td></tr>
<tr><td rowspan="2">01</td><td rowspan="2">LGO_Ux
LAU
LXU
LPMA</td><td>00: LGO_Ux</td><td>0001: LGO_U1
0010: LGO_U2
0011: LGO_U3
Others: Reserved</td></tr>
<tr><td>01: LAU
10: LXU
11: LPMA</td><td>Reserved (0000)</td></tr>
<tr><td>10</td><td>LDN
LUP</td><td>00: LUP
11: LDN
Others: Reserved</td><td>Reserved (0000)</td></tr>
<tr><td>11: Reserved</td><td>Reserved</td><td>Reserved (0000)</td><td>Reserved (0000)</td></tr>
</table>

USB 3.0 ENGINEERING CHANGE REQUEST FORM

(b). From Text (and location): Table 7-5

Table 7-5. Link Command Definitions

Link Command	Definition – See Sections 7.2.4.1, 7.2.4.2, and 7.5.6 for detailed use and requirements.
LGOOD_n	n (0, 1, 2, ...7): Header Sequence Number. Sent by a port receiving a header packet when all of the following conditions are true: • The header packet has a valid structure and can be recognized by the receiver. • CRC-5 and CRC-16 are valid. • Header Sequence Number in the received header packet matches the expected Rx Header Sequence Number. • An Rx Header Buffer in the receiver is available for storing the received header packet. Mismatch between a Header Sequence Number in the received header packet and the expected Rx Header Sequence Number will result in a port transitioning to Recovery. Received by a port sending a header packet. This is an acknowledgement from a link partner that a header packet with the Header Sequence Number of "n" is received properly. Receipt of LGOOD_n mismatching the expected ACK Tx Header Sequence Number will result in a port transitioning to Recovery. Also sent by a port upon entry to U0 as the Header Sequence Number Advertisement to initialize the ACK Tx Header Sequence Number of the two ports. (see Section 7.2.4.1 for details)
LBAD	Bad header packet. Sent by a port receiving the header packet in response to an invalid header packet. Packet that was received has corrupted CRC-5 and/or CRC-16. Receipt of LBAD will cause a port to resend all header packets after the last header packet that has been acknowledged with LGOOD_n. (see Section 7.2.4.1 for details)
LCRD_x	x (A, B, C, D): Rx Header Buffer Credit Index. Signifies that a single Rx Header Buffer Credit has been made available. Sent by a port after receiving a header packet that meets the following criteria • LGOOD_n is sent. • The header packet has been processed, and an Rx Header Buffer Credit is available. LCRD_x is sent in the alphabetical order of A, B, C, D, and back to A without skipping. Missing LCRD_x will cause the link to transition to Recovery. (see Section 7.2.4.1 for details)
LRTY	Sent by a port before resending the first header packet in response to receipt of LBAD.
LGO_U1	Sent by a port requesting entry to U1.
LGO_U2	Sent by a port requesting entry to U2.
LGO_U3	Sent by a downstream port requesting entry to U3. An upstream port shall accept the request.
LAU	Sent by a port accepting the request to enter U1, U2, or U3.
LXU	Sent by a port rejecting the request to enter U1 or U2.
LPMA	Sent by a port upon receiving LAU. Used in conjunction with LGO_Ux and LAU handshake to guarantee both ports are in the same state.
LUP	Device present in U0. Sent by an upstream port every 10 µs when there are no packets or other link commands to be transmitted. Refer to Section 7.5.6.1 for details.

USB 3.0 ENGINEERING CHANGE REQUEST FORM

To Text (and location):

Table 7-5. Link Command Definitions

Link Command	Definition – See Sections 7.2.4.1, 7.2.4.2, and 7.5.6 for detailed use and requirements.
LGOOD_n	n (0, 1, 2, ...7): Header Sequence Number. Sent by a port receiving a header packet when all of the following conditions are true: • The header packet has a valid structure and can be recognized by the receiver. • CRC-5 and CRC-16 are valid. • Header Sequence Number in the received header packet matches the expected Rx Header Sequence Number. • An Rx Header Buffer in the receiver is available for storing the received header packet. Mismatch between a Header Sequence Number in the received header packet and the expected Rx Header Sequence Number will result in a port transitioning to Recovery. Received by a port sending a header packet. This is an acknowledgement from a link partner that a header packet with the Header Sequence Number of "n" is received properly. Receipt of LGOOD_n mismatching the expected ACK Tx Header Sequence Number will result in a port transitioning to Recovery. Also sent by a port upon entry to U0 as the Header Sequence Number Advertisement to initialize the ACK Tx Header Sequence Number of the two ports. (see Section 7.2.4.1 for details)
LBAD	Bad header packet. Sent by a port receiving the header packet in response to an invalid header packet. Packet that was received has corrupted CRC-5 and/or CRC-16. Receipt of LBAD will cause a port to resend all header packets after the last header packet that has been acknowledged with LGOOD_n. (see Section 7.2.4.1 for details)
LCRD_x	x (A, B, C, D): Rx Header Buffer Credit Index. Signifies that a single Rx Header Buffer Credit has been made available. Sent by a port after receiving a header packet that meets the following criteria • LGOOD_n is sent. • The header packet has been processed, and an Rx Header Buffer Credit is available. LCRD_x is sent in the alphabetical order of A, B, C, D, and back to A without skipping. Missing LCRD_x will cause the link to transition to Recovery. (see Section 7.2.4.1 for details)
LRTY	Sent by a port before resending the first header packet in response to receipt of LBAD.
LGO_U1	Sent by a port requesting entry to U1.
LGO_U2	Sent by a port requesting entry to U2.
LGO_U3	Sent by a downstream port requesting entry to U3. An upstream port shall accept the request.
LAU	Sent by a port accepting the request to enter U1, U2, or U3.
LXU	Sent by a port rejecting the request to enter U1 or U2.
LPMA	Sent by a port upon receiving LAU. Used in conjunction with LGO_Ux and LAU handshake to guarantee both ports are in the same state.
LDN	Downstream port present in U0. Sent by a downstream port every 10 µs when there are no packets or other link commands to be transmitted. Refer to Section 7.5.6.1 for details.
LUP	Device present in U0. Sent by an upstream port every 10 µs when there are no packets or other link commands to be transmitted. Refer to Section 7.5.6.1 for details.

USB 3.0 ENGINEERING CHANGE REQUEST FORM

(c). From Text (and location): 7.2.2.2 Link Command Word Definition

LUP is a special link command used by an upstream port to indicate its port presence in U0. The usage of LUP is described in Table 7-5.

To Text (and location):

LDN and LUP are special link commands used by a downstream port and an upstream port to indicate their port presence in U0. The usage of LDN and LUP is described in Table 7-5.

(d). From Text (and location): 7.2.4.1.1 Initialization

- The following rules shall be applied additionally when a port enters U0 from Recovery:
  1. A port sending LBAD before Recovery shall not expect to receive LRTY before a retried header packet from its link partner upon entry to U0.
  2. A port receiving LBAD before Recovery shall not send LRTY before a retried header packet to its link partner upon entry to U0.

     Note: There exists a situation where an LBAD was sent by a port before Recovery and it may or may not be received properly by its link partner. Under this situation, the rules of LBAD/LRTY do not apply. Refer to Sections 7.2.4.1.4 and 7.2.4.1.9 for details.
  3. An upstream port may send LUP during link initialization.

To Text (and location):

- The following rules shall be applied additionally when a port enters U0 from Recovery:
  1. A port sending LBAD before Recovery shall not expect to receive LRTY before a retried header packet from its link partner upon entry to U0.
  2. A port receiving LBAD before Recovery shall not send LRTY before a retried header packet to its link partner upon entry to U0.

     Note: There exists a situation where an LBAD was sent by a port before Recovery and it may or may not be received properly by its link partner. Under this situation, the rules of LBAD/LRTY do not apply. Refer to Sections 7.2.4.1.4 and 7.2.4.1.9 for details.

USB 3.0 ENGINEERING CHANGE REQUEST FORM

(e). From Text (and location): 7.3.4 Link Command Errors

- A downstream port detecting missing of LUP shall transition to Recovery (refer to Section 7.5.6 for LUP detection).

To Text (and location):

- A downstream port detecting missing of LUP shall transition to Recovery (refer to Section 7.5.6 for LUP detection).
- An upstream port detecting missing of LDN shall transition to Recovery (refer to Section 7.5.6 for LDN detection).

(f). From Text (and location): 7.5.6.1 U0 Requirements

- An upstream port shall enable a 10-µs timer. This timer shall be reset when the first symbol of any link command or packet is sent and restarted after the last symbol of any link command or packet is sent. This timer shall be active when the link is in logical idle.
- An upstream port shall transmit a single LUP when the 10-µs timer expires.

To Text (and location):

- A downstream port and an upstream port shall enable a 10-µs timer. This timer shall be reset when the first symbol of any link command or packet is sent and restarted after the last symbol of any link command or packet is sent. This timer shall be active when the link is in logical idle.
- A downstream port shall transmit a single LDN when the 10-µs timer expires.
- An upstream port shall transmit a single LUP when the 10-µs timer expires.

(g). From Text (and location): 7.5.6.2 Exit from U0

- A downstream port shall transition to Recovery upon not receiving any link commands within 1-ms.
  Note: Not receiving any link commands including LUP within 1 ms implies either a link is under serious error condition, or an upstream port has been removed. To accommodate for both situations, a downstream port will transition to Recovery and attempt to retrain the link. If the retraining fails, it will then transition to SS.Inactive. During SS.Inactive, a downstream port will attempt a far-end receiver termination detection. If it determines that a far-end low-impedance receiver termination ($R_{RX\text{-}DC}$) defined in Table 6-13 is not present, it will enter Rx.Detect. Otherwise, it will wait for SW intervention.

To Text (and location):

- A downstream port shall transition to Recovery upon not receiving any link commands within 1-ms.
  Note: Not receiving any link commands including LUP within 1 ms implies either a link is under serious error condition, or an upstream port has been removed. To accommodate for both situations, a downstream port will transition to Recovery and attempt to retrain the link. If the retraining fails, it will then transition to SS.Inactive. During SS.Inactive, a downstream port will attempt a far-end receiver termination detection. If it determines that a far-end low-impedance receiver termination ($R_{RX\text{-}DC}$) defined in Table 6-13 is not present, it will enter Rx.Detect. Otherwise, it will wait for SW intervention.
- An upstream port shall transition to Recovery upon not receiving any link commands within 1-ms.

USB 3.0 ENGINEERING CHANGE REQUEST FORM

(h). From Text (and location): 7.2.2.2 Link Command Word Definition

Link commands are defined for four usage cases. First, link commands are used to ensure the successful transfer of a packet. Second, link commands are used for link flow control. Third, link commands are used for link power management. And finally, a special link command is defined for an upstream port to signal its presence in U0.

To Text (and location):

Link commands are defined for four usage cases. First, link commands are used to ensure the successful transfer of a packet. Second, link commands are used for link flow control. Third, link commands are used for link power management. And finally, special link commands are defined for a port to signal its presence in U0.